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EVALUATION OF PROCESSING TOMATO BREEDING LINES AND CULTIVARS FOR MECHANICAL HARVESTING AND QUALITY IN 1995

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Summary

Processing tomato breeding at The Ohio State University and the Ohio Agricultural Research and Development Center (OARDC) continued to focus on the development of cultivars for the midwest U.S. processing industry. A survey of growers and processors in Indiana, Michigan, and Ohio was conducted to help prioritize the efforts of the OARDC tomato breeding and genetics program. The major concerns associated with environmental stress and horticultural characteristics are manifested as fruit quality traits. The results of the survey were therefore tabulated into two groups, disease resistance and fruit quality, and are summarized in Table 2. The diseases bacterial canker, anthracnose, bacterial spot, early blight, and bacterial speck ranked in the top five for the 1992, 1993, and 1994 growing seasons. Bacterial canker, bacterial spot, anthracnose, and early blight remained major concerns in 1995. Color was the fruit quality trait of most importance. Soluble solids, firmness, holding ability, and consistency also rank among the top priorities for improving fruit quality. Yield stability, uniformity of fruit set, and uniformity of fruit size were concerns that do not fit into the disease resistance or fruit quality categories.

To address grower and processor concerns, work has been initiated to improve disease resistance, earliness, and fruit quality. Crosses have been made to introduce resistance to bacterial spot and bacterial speck races present in the midwest. Early generation evaluation of this material is in progress as a collaborative effort with Dr. S.A. Miller (OSU, OARDC). Germplasm is being evaluated in collaboration with Dr. M. Hausbeck and Dr. D. Fulbright (Michigan State University) in order to identify a potential source of resistance to bacterial canker isolates collected from processing tomatoes in Ohio and Michigan. Evaluation and selection continued in unsprayed plots with strong disease pressure from *Alternaria solani* (early blight) and *Colletotricum* spp. (anthracnose). Crosses have also been made to introduce an early fruit ripening trait from material developed at Cornell University and North Carolina State University. Objective color measurements of whole-pack tomatoes have been expanded to include color uniformity as well as absolute color. In addition, objective measurements of fruit firmness have been incorporated into our quality evaluation. We continue to include measurements of pH, percent citric acid, and soluble solids in our evaluation of fruit quality attributes.

Selection for earliness, fruit set, crack resistance, holding ability and improved yield were conducted at the OARDC branches in Freemont and Wooster, and 450 selections were advanced. The hybrids OX38, OX42, OX52, OX53, OX70, OX72, OX88, and OX139 performed well based on yield (Table 3) and absolute color (Table 4). In addition, OX42, OX52, and OX88 displayed exceptional color uniformity. Hybrids OX38, OX42, OX52, OX53, OX72, and OX88 had acceptable levels of firmness, with OX38, OX42, OX52, and OX72 displaying exceptional firmness (Table 4). OX42 had the highest soluble solids of any Ohio State hybrid (Table 4). An open pollinated breeding line, E3111, that combines firmness with the excellent color and high lycopene qualities of crimson fruit (ogc) was also identified (Table 4).

Methods and Results

Industry Survey: Questionnaires were sent to growers and processors to seek input in order to help set goals for the OARDC tomato breeding program. Questionnaires asked for a list of the top five concerns for the 1992, 1993, and 1994 growing season ranked according to importance. Categories included diseases, environmental stress, fruit quality, and horticultural characteristics. The major concerns associated with environmental stress and horticultural characteristics are

manifested as fruit quality traits. The results of the survey were therefore tabulated into two groups, disease resistance and fruit quality, and are summarized in Table 2. Yield stability, uniformity of fruit set, varietal purity, and uniformity of fruit size were concerns that do not fit into the disease resistance or fruit quality categories but will be emphasized in the normal course of field evaluation and selection.

Fourteen surveys were returned. To tabulate the survey results, points were assigned each trait and ranged from 5 for the most important to 1 for the least important. Because individual surveys often listed different traits in the top five (especially with regard to fruit quality), the survey data was unbalanced. Some traits were ranked high by a few processors while others were ranked mid to low by many processors. To reflect the unbalanced data, traits were tabulated according two to criteria. First, adjusted means were calculated by adding all points for a given trait and dividing by the number of individuals listing the trait on their survey. Adjusted means are therefore weighted toward traits assigned high values by only a few individuals or companies (**1B** and **1D**). The highest adjusted mean possible is 5. Second, adjusted scores were calculated by multiplying the adjusted mean by the number of individuals listing the trait on their survey. Adjusted scores represent an average for those responding to the survey (**1A** and **1C**). The highest possible adjusted score is 70. For disease resistance, differences between 1A and 1B were minor, and tended to reflect geographic location of the individuals responding. For fruit quality traits, Differences between 1C and 1D reflect differences in priorities between whole-pack and product processors.

Field Trials: Data discussed in this report were obtained from two replicated trials at the OARDC Vegetable Crops Branch, Freemont. Beds were prepared in the silty clay loam soil Nov. 1, 1994. Fertilizer applications included broadcasts of 1 Ton/ A agricultural limestone (Oct. 17, 1994), 550 lb/A 0-11-46 (Oct. 14, 1994), and 220 lb/A 34-0-0 (May 22, 1995). Herbicide applications included 0.5 lb/A Sencor Solupak and 1.25 pt/A Trifluralin 4EC incorporated 2 inches deep (May 22, 1995) and 0.46 lb/A Sencor DF (Jul. 7, 1995). Plant material was prepared as transplants from the greenhouse, 108 per standard flat. Seed was sown April 6 for a 4-replicate trial and April 10 for a 2-replicate trial. Trials were transplanted June 6 (4-replicate trial) and June 7 (2-replicate trial) using a two row transplanter and 1/2 pint of starter fertilizer (10-34-0 diluted 1 qt. in 50 gal H_2O). Each plot consisted of a single-row planting, 20 plants per row, spaced 12 inches, and rows 5 ft apart. Insect and disease control followed TOMCAST recommendations. Weather data are presented in Table 1.

Harvest: Harvest was timed to coincide with the time that marketable fruit were approaching optimum recovery. A Johnson tomato harvester was used for once over machine-harvest. Yield data were collected for usable ripe-red fruit (lb/plot) and converted to ton/A based on a planting density of 12,000 plants/A. Percentages of usable fruit, green fruit, and culled fruit, are expressed on a weight basis (Table 3). Early season rains followed by hot and dry weather contributed to fruit softening and breakdown (Table 1). Cull percentages were therefore high.

Fruit Quality Evaluation: Fruit quality evaluation was performed in the small fruit quality lab, OARDC, Wooster. Replicated measurements were taken on fruit firmness, fruit color, soluble solids, pH, and titratable acidity. Firmness measurements were based on the force needed to rupture fruit using an Instron model 1011 equipped with a star press probe. Descent rate was set at 50 mm/min and the instrument calibrated to 5 Kg force. Seven to ten fruit were measured per plot. Force to rupture (first peak) and shear force (second peak) were measured in grams. Distance to first and second peaks was measured in millimeters. Data are presented on force to rupture (Table 4) as this value provides a good measure of fruit firmness.

Color measurements were based on the metric standard color space (CIELAB or L*a*b*) using a Minolta CR 100 colorimeter with an 8 mm reading diameter and the standard daylight illuminant (C). Fruit were cut along the stem scar end to remove the peal and reveal the mesocarp tissue (though not the locule) and two measurements were taken from opposite sides of each fruit. Stem scar end color evaluation was performed on ten to twenty fruit per plot for both trials, providing up to six replicates for some varieties. Color data were converted to descriptive measurements including L* , a measure of lightness; hue angle, a measure of color; and chroma, a

measure of saturation or vividness (Table 4). Hue angle correlates very well (>0.95) with A/B ratio formerly reported for tomato fruit quality.

Measurements of soluble solids, pH, and titratable acidity were performed on a puree of a representative sample of fruit for each plot (8-10 fruit). Soluble solids were measured using an American Optic Abbe Refractometer. The raw sample (10 ml) was diluted 1/5 with distilled water for pH determination, followed by direct titration using 0.1 N NaOH to a final pH of 8.1. Titratable acidity was converted to percent citric acid by the correction factor 0.064. Results are reported in Table 4.

Data Analysis and Presentation: Many factors determine the potential of a new variety. For this reason we have included figures in this report that display some of the results as a scatter graph with both fruit quality traits and yield. These graphs make it easier to identify varieties and breeding lines with a promising combination of traits. Color vs Yield are presented for each of the harvest dates for the 4-replicate trial in Figures 1-3. Yield vs firmness are presented for all 45 entries in the 4-replicate trial in Figure 4.

Field trials are subject to environmental variation that can obscure differences between varieties. The use of replication can reduce (though not eliminate) the effects of variation due to environment. The Least Significant Difference (LSD 0.05) statistic provides a means of comparing two varieties. When the difference between the trait mean of two varieties exceeds the LSD, the difference between the varieties is probably due to a genetic difference rather than environmental variation.

In this years report we present both the average value and the standard deviation of measurements where appropriate. The standard deviation is presented as a measure of the variability for each trait. In some cases, the uniformity of a trait may be more important than the absolute value for that trait. We have used the measurement of variability in fruit color as an example and results are presented in Table 5. The standard deviation of hue angle (fruit color) differed between genotypes and provided more discrimination between genotypes than absolute color based on hue angle.

Finally, 1995 represents a transition year as the OARDC tomato breeding and genetics program passed from Dr. Berry's leadership to that of Dr. Francis. We have taken this opportunity to summarize maturity and yield data for the last three years from trials at the OARDC Vegetable Crops Branch. Data from promising hybrids and several industry standards are presented in Table 6.

Research Support

The assistance of Mid America Food Processors Association is gratefully acknowledged.

References

Berry, S.Z, Aldrich, T.S., Wiese, K. L. , and Bash, W.D. 1995 'Ohio OX 38' Hybrid processing tomato. HortScience 30:159.

Tables and Figures

Table 1. Weather Data (OARDC, Freemont, Ohio)

	Temperature (Farenheit)		Rainfall (inches)	
	1994	43 Yr. Aver.	1994	43 Yr Avg.
May	58.5	59.4	4.78	3.57
June	69.9	69.1	3.05	3.96
July	73.8	73.0	3.5	3.86
August	74.7	70.8	3.44	3.47
September	59.7	63.8	1.44	3.00

Table 2. Summary of Industry Survey. Questionnaires asked for a list of the top five concerns for the 1992, 1993, and 1994 growing season ranked according to importance. Points were assigned each trait and ranged from 5 for the most important to 1 for the least important. The traits were then ranked according two to criteria. First, adjusted means were calculated by adding all points for a given trait and dividing by the number of individuals listing the trait on their survey. Adjusted means are therefore weighted toward traits assigned high values by only a few individuals or companies (**1B** and **1D**). The highest adjusted mean possible is 5. Second, adjusted scores were calculated by multiplying the adjusted mean by the number of individuals listing the trait on their survey. Adjusted scores represent an average for those responding to the survey (**1A** and **1C**). The highest possible adjusted score is 70.

Disease Resistance:

1 A. Adjusted Score

Disease	Score	Disease	Score	Disease	Score
1992		1993		1994	
1. early blight	42	early blight	42	bacterial canker	51
2. anthracnose	40	bacterial canker	40	early blight	42
3. bacterial spot	32	anthracnose	34	anthracnose	33
4. bacterial speck	30	bacterial speck	31	bacterial spot	21
5. bacterial canker	26	bacterial spot	25	bacterial speck	21

1 B. Adjusted Mean

Disease	Score	Disease	Score	Disease	Score
1992		1993		1994	
1. anthracnose	3.63	bacterial canker	4.0	bacterial canker	3.92
2. early blight	3.50	bacterial speck	3.88	anthracnose	3.67
3. bacterial speck	3.33	early blight	3.50	bacterial spot	3.29
4. bacterial canker	3.25	anthracnose	3.40	early blight	3.23
5. bacterial spot	3.20	bacterial spot	2.5	bacterial speck	3.0

Fruit Quality:

1 C. Adjusted Score

Trait	Score	Trait	Score	Trait	Score
1992		1993		1994	
1. Color	44	Color	51	Color	56
2. Firmness	21	Soluble Solids	16	Soluble Solids	23
3. Soluble Solids	14	Firmness	14	Firmness	18
4. Holding Ability	10	Blossom end rot	14	Holding Ability	9
5. Consistency	9	Holding ability	6	Veins	7

1 D. Adjusted Mean

Trait	Score	Trait	Score	Trait	Score
1992		1993		1994	
1. Consistency	4.5	Consistency	5.0	Soluble Solids	4.6
2. Color	4.4	Color	4.25	Color	4.31
3. Cracking	4.0	Soluble Solids	4.0	Consistency	4.0
4. Firmness	3.5	Cracking	4.0	Veins	4.0
5. Soluble Solids	3.5	Fruit Size	4.0	Firmness	3.6

Table 3. Mechanical harvest evaluation of processing tomato varieties and test lines when ripe fruit was approaching optimum recovery. Results are averaged over 4 replicated plots. Vegetable Crops Branch, OARDC, Freemont, OH 1995.

Variety or Test Line	Ripe Usable (T/A)	sdev	% of Potential Ripe	Green	Cull	Fruit size (oz.)	sdev
Harvest Date 9/5/95							
OX53	33.9	9.8	78	9	13	2.3	0.1
OX139	33.2	4	80	6	14	2.2	0
SO12	31.4	3.5	77	14	9	1.8	0.1
OX3	29.5	7.6	75	12	13	2.1	0.1
SO90	28.9	5.9	80	9	12	2.6	0.2
OX88	28.7	7.7	76	10	14	2.1	0.1
OX120	28.5	3.5	75	8	17	2.5	0.3
O8556	28.5	2.8	74	6	21	2.6	0.1
E3228	26.2	3	73	10	17	2.4	0.1
SO47	25.3	10.5	77	7	16	2.4	0.3
OX9	23.5	11.5	74	10	17	2.6	0.3
O9435	22.1	5.1	70	9	21	2.5	0.2
Harvest Date 9/6/95							
OX72	37.4	9.1	80	13	7	2.2	0.1
OX70	36.0	3.1	80	7	12	2.4	0.1
E1856	34.7	3.7	81	9	10	2.4	0.1
PS2196	34.6	6.2	81	12	7	2.5	0.2
OX38	34.5	5.3	81	13	7	2.3	0.1
OX64	33.3	6.6	78	10	12	2.1	0.1
OX137	30.5	6.7	82	5	13	2.4	0.1
O88119	30.5	1.1	73	16	11	2.5	0.1
R9201	30.2	5.7	75	11	14	2.2	0.1
O87160	30.0	0.9	73	14	14	2.2	0.1
OX42	29.9	7	81	14	6	2.2	0.1
O9436	28.9	5	75	12	14	2.6	0.2
O9241	27.0	1.2	71	14	14	2.5	0.1
O9439	27.0	4.9	75	8	17	2.2	0.4
O9442	26.7	3.8	82	9	10	2.1	0
O9441	26.5	8.8	82	5	13	2.5	0.1
O87175	26.3	6.4	78	6	16	2.2	0
O9244	26.1	4.1	73	12	16	2.6	0.1
O7983	25.8	5.2	82	6	12	2.5	0.1
O86120	24.2	8.5	71	9	20	2.2	0.1
Harvest Date 9/13/95							
PS696	40.6	6.1	85	8	7	2.6	0.2
OX52	39.0	8.2	82	10	9	2.1	0.1
O8446	36.5	3.9	81	11	9	2.7	0.1
E3096	33.7	10.1	82	5	13	2.5	0.1
E3097	32.3	7.5	82	11	7	2.4	0.2
O8245	28.8	9.6	78	17	4	2.5	0.2
E3259	27.8	3.7	78	15	8	2.5	0.1
O8675	27.8	7	75	13	12	2.2	0.2
E3111	25.8	2.7	81	6	14	2.9	0.2
O8550	25.0	5.8	70	9	21	2.8	0.3
O8444	23.8	3.9	77	13	11	2.7	0.1
O8689	18.8	6.3	68	12	20	2.7	0.1
E3211	16.4	1.7	65	10	25	2.7	0.2
LSD 0.05	8.72					0.22	
C.V.	21.33					6.59	

Table 4. Laboratory evaluation of fruit quality for processing tomato varieties and test lines.

Variety or Test Line	% Soluble Solids	pH	% Total acid as Citric	Color evaluation L*	sdev	Hue	sdev	Chroma	sdev	Force to rupture (gm)	sdev
Harvest Date 9/5/95											
OX53	3.7	4.2	0.32	42.5	5.5	47.1	7.9	30.6	4	1262	227
OX139	3.8	4.2	0.35	41.7	6.1	46.3	11.9	31.2	3.8	1171	267
SO12	3.9	4.1	0.37	40.5	3.6	46.3	6.2	31.9	3.1	1368	310
OX3	3.9	4.1	0.35	43.5	7.7	47.9	6.5	32.3	5	1311	299
SO90	3.8	4.1	0.37	41.1	4.1	44.1	6.3	32.2	4.2	1354	262
OX88	3.9	4.1	0.34	41.8	3.9	46.4	6.4	32.4	3.3	1247	278
OX120	3.8	4.2	0.35	41.7	5.5	46.3	13.7	32.2	3.3	1072	262
O8556	4	4.2	0.4	41.0	5.9	43.9	9.7	31.3	4.3	1059	304
E3228	4	4.1	0.4	42.1	3.8	45.2	7.2	30.9	2.9	1182	256
SO47	4.2	4.2	0.37	42.2	6.6	47.8	11.9	31.6	4.4	1290	287
OX9	3.8	4.1	0.4	42.7	6.9	46.5	5.8	34.4	5.5	1232	266
O9435	4.1	4.1	0.38	41.2	6.6	45.6	7.6	30.9	5.3	1083	317
Harvest Date 9/6/95											
OX72	3.7	4.1	0.28	45.8	7.2	55.2	14.3	33.5	3.6	1456	312
OX70	3.8	4.1	0.31	45.2	5.8	51.5	14.3	34	3.3	1164	271
E1856	3.8	4.1	3.7	43.1	4.7	46.7	9.2	33.6	2.8	1208	266
PS2196	3.8	4.1	0.4	44.7	5.9	52.6	15.2	33.5	3.1	1369	341
OX38	3.8	4.1	0.37	44.4	4.9	50.7	13.9	34.6	2.8	1752	500
OX64	3.6	4.1	0.33	49.2	9.3	59.6	19.6	32.9	3.3	1367	243
O88119	3.5	4.2	0.29	45.2	7.5	54.4	18.1	33.3	3.6	1319	305
OX137	4.1	4.1	0.38	43.1	6.1	52.6	17.5	32	3.6	1266	295
R9201	3.9	4.2	0.37	43.4	5.6	47.6	12.4	33	2.6	1081	231
O87160	3.7	4.2	0.3	45.6	7.2	57.2	20	32.7	3.6	1339	244
OX42	4.2	4	0.35	44.5	4.8	49.7	8.2	32.8	2.9	1533	347
O9436	3.7	4.2	0.39	42.9	6.5	50.7	19.5	33	4.1	1139	310
O9241	4.4	4.1	0.37	42.9	5.8	48.1	11.3	32.2	3.1	1421	411
O9439	4.3	4.2	0.39	43.4	6.6	49.4	12.2	33	3.5	1191	282
O9442	4.4	4.1	0.42	41.5	3.7	48.5	6.4	32.2	3.2	1524	264
O9441	3.9	4.2	0.32	43.8	8.2	51.9	17.4	30.9	4.25	1198	234
O87175	4.2	4.3	0.34	40.9	3.7	45.1	5.2	32.1	2.7	1004	240
O9244	3.7	4.1	0.37	43	5.5	48.8	13.1	31.5	3	1117	254
O7983	4.2	4.1	0.4	43.5	5.8	53.3	16.6	33.6	3.8	1469	388
O86120	4.2	4.1	0.44	44.1	7.3	54.8	20	31.3	3.8	997	247
Harvest Date 9/13/95											
PS696	3.7	4.1	0.41	43.1	5.4	47.7	7.3	31.7	2.7	1658	416
OX52	3.7	4.3	0.38	41.1	2.6	47.3	2.7	32.4	2.8	1390	216
O8446	3.5	4.1	0.39	42.1	3.0	46.8	3.3	33.9	2.9	1457	179
E3096	4.1	4.1	0.41	42.8	5.4	47.9	4.3	29.9	4.2	1381	423
E3097	3.5	4.2	0.36	43.4	4.7	50	7.7	32.8	3.6	1509	403
O8245	4.3	4.1	0.44	44.2	2.9	48.3	3.5	31.9	3.6	1949	503
E3259	4.3	4.2	0.46	40.1	2.4	44.1	3.6	32.5	2.3	1775	452
O8675	4.2	4.1	0.39	44.1	5.4	51.2	6.5	29.5	3.6	1471	354
E3111	4.2	4.1	0.42	41.6	2.6	45.5	2.5	33.8	2.7	1486	286
O8550	4.1	4.2	0.42	43.6	3.3	46	4.7	29.9	3.1	1289	280
O8444	4.5	4.1	0.5	40.4	4.4	47.3	3.8	29.6	3.8	1287	325
O8689	4.2	4.4	0.33	40.1	3.0	45.2	3.1	29.7	3.1	1422	287
E3211	4.4	4.2	0.41	39.9	2.8	44.1	3	30.7	3.12	1237	333
LSD (0.05)	0.55	0.13	0.06	4.58		4.66		1.46		170.8	
C.V.	9.92	2.22	10.73	13.14		23.72		11.24		23.6	

Figure 1

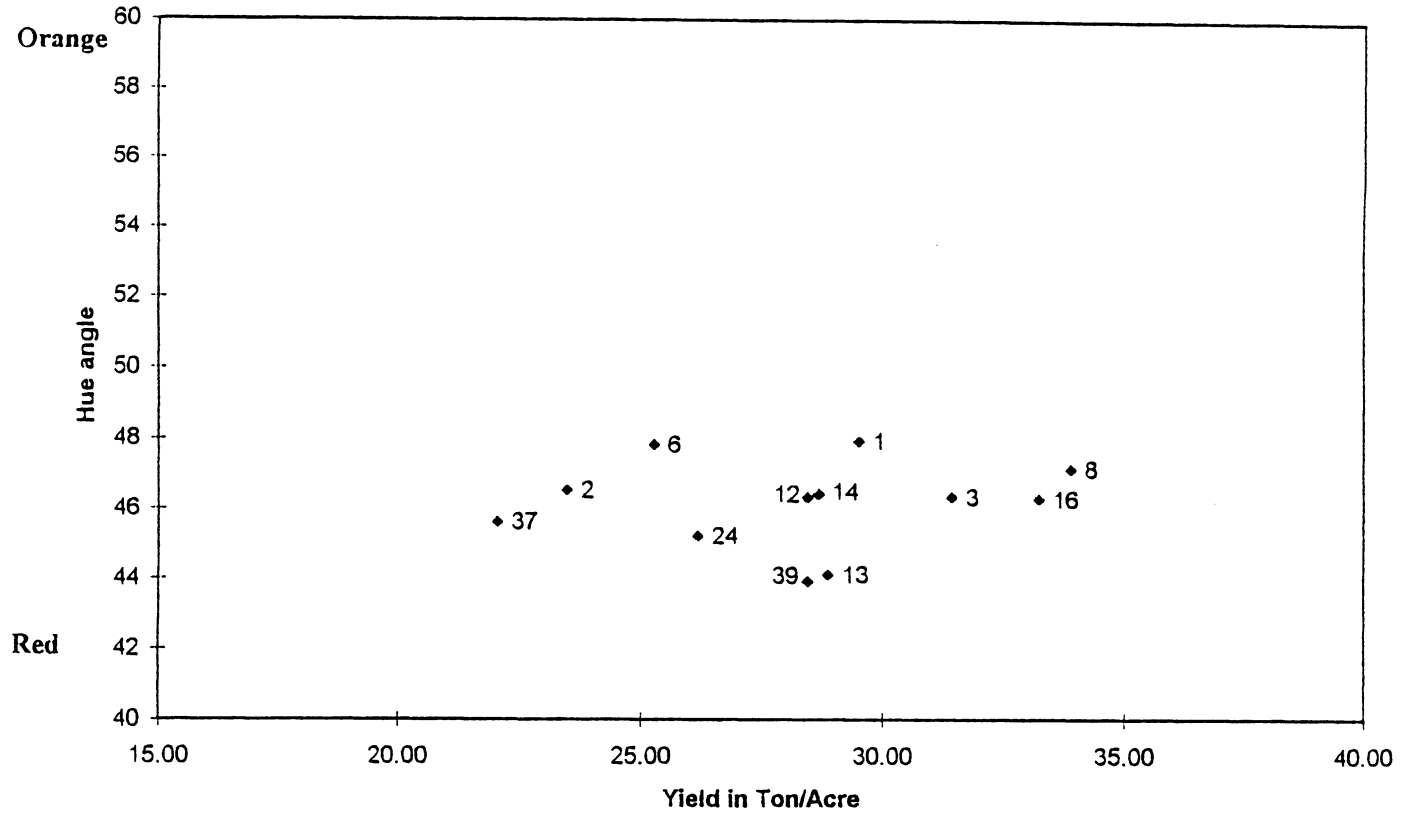

Figure 2

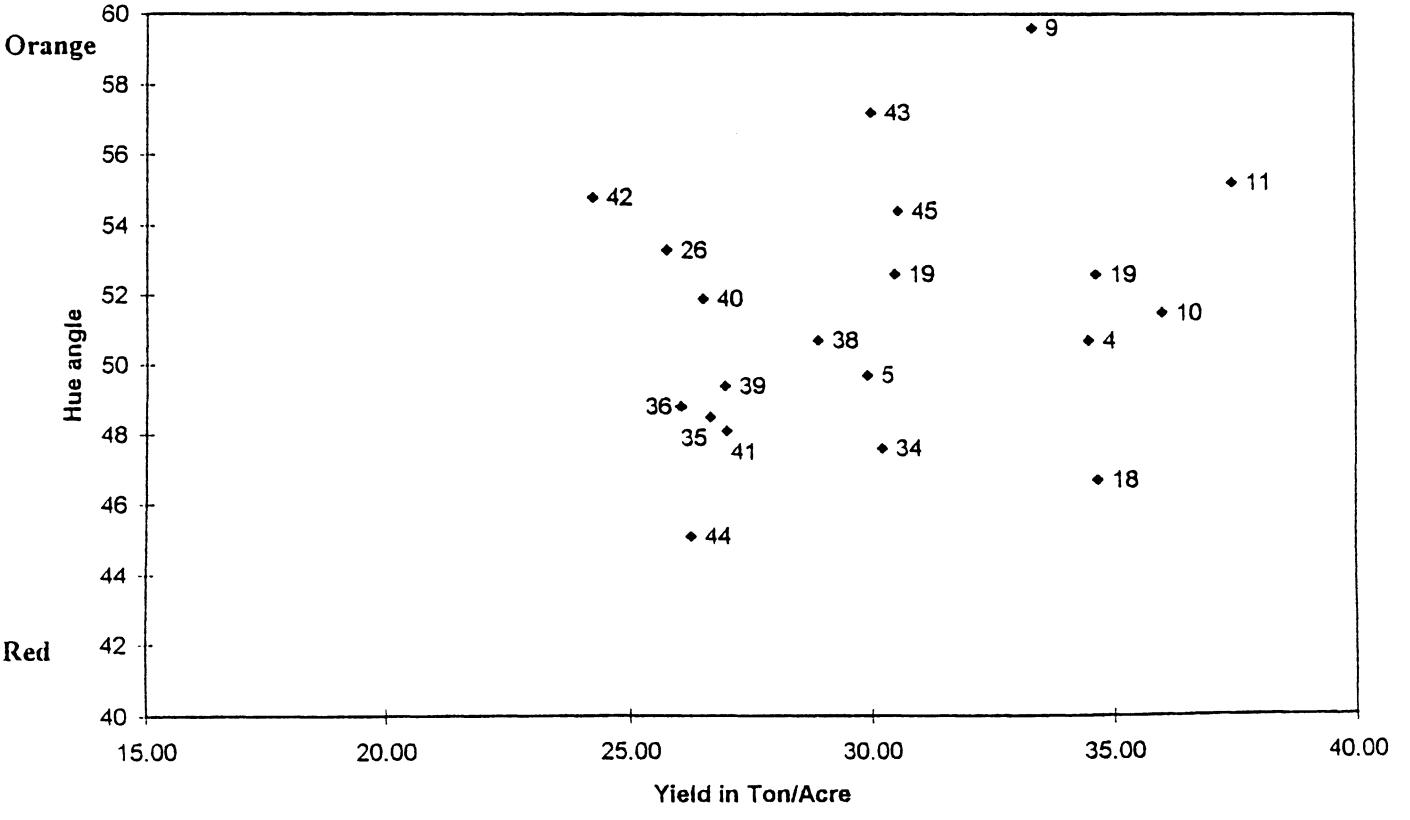

Figure 3

Key to Figures:

1.	OX3	16.	OX139	31.	O8556
2.	OX9	17.	PS696	32.	O8675
3.	SO12	18.	E1856	33.	O8689
4.	OX38	19.	PS2196	34.	RCAT9201
5.	OX42	20.	E3096	35.	O9241
6.	SO47	21.	E3097	36.	O9244
7.	OX52	22.	E3111	37.	O9435
8.	OX53	23.	E3211	38.	O9436
9.	OX64	24.	E3228	39.	O9439
10.	OX70	25.	E3259	40.	O9441
11.	OX72	26.	O7983	41.	O9442
12.	OX88	27.	O8245	42.	O86120
13.	SO90	28.	O8444	43.	O87160
14.	OX120	29.	O8446	44.	O87175
15.	OX137	30.	O8550	45.	O88119

Figure 4

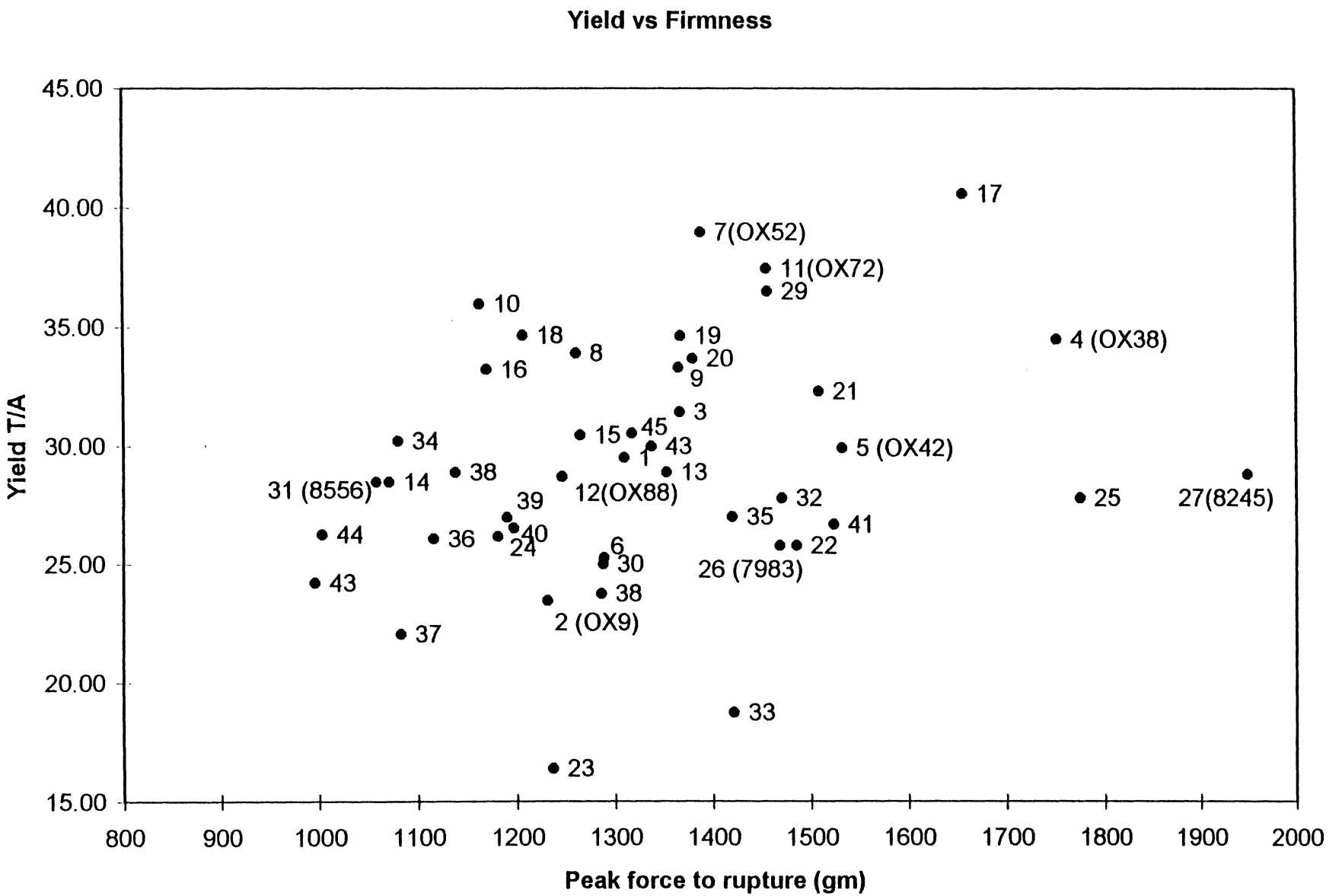
Yield vs Firmness
Yield T/A
Peak force to rupture (gm)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
17
7(OX52)
11(OX72)
29
10
18
8
19
20
16
9
4 (OX38)
21
3
34
15
45
43
1
5 (OX42)
13
31 (8556)
14
38
12(OX88)
39
32
25
27(8245)
35
41
44
36
40
24
6
22
30
26 (7983)
43
38
2 (OX9)
37
33
23

Table 5. Color evaluation of selected Varieties based on Results from 6 plots.

Fig. Key	Variety	Hue [a]	Rank	SDev	Rank	LN(SDev)	Rank
9	OX64	56.7	13	12.8	12	2.3	11
15	OX137	52.1	12	14.3	13	2.5	13
11	OX72	51.7	11	12.2	11	2.1	10
4	OX38	51.0	10	11.9	10	2.3	12
26	O7983	50.4	9	8.9	8	1.9	8
5	OX42	50.1	8	6.6	5	1.8	7
27	O8245	48.8	7	5.2	3	1.6	3
17	PS696	48.7	6	6.6	4	1.6	4
7	OX52	48.6	5	4.4	2	1.3	1
8	OX53	48.3	4	7.4	6	1.8	6
16	OX139	47.7	3	7.8	7	1.8	5
14	OX120	47.1	2	10.2	9	2.1	9
12	OX88	47.0	1	4.1	1	1.3	2
LSD (0.05)		5.8		7.5		0.8	

[a] Hue is CIELAB hue angle in degrees averaged over 6 plots.

Table 6. Summary of Maturity and Relative Yield over 3 years.

Fig. Key	Variety	Maturity[a]	Sdev	Relative Yield[b]	Sdev
27	O8245	105.5	8.1	-0.4	1.6
17	PS696	104.3	9.3	4.6	2.1
5	OX42	103.8	10.8	5.3	5.9
4	OX38	102.0	8.8	4.0	0.6
7	OX52	102.0	5.6	10.4	2.9
8	OX53	101.7	13.0	6.5	4.3
15	OX137	101.0	7.1	-3.1	4.9
26	O7983	98.8	7.6	-2.2	2.6
14	OX120	98.5	13.4	0.3	3.0
11	OX72	98.0	9.2	3.0	4.4
9	OX64	98.0	9.2	2.4	0.4
12	OX88	97.7	9.6	1.5	3.3
16	OX139	97.5	12.0	0.0	2.2

[a] Maturity in days from transplant to harvest averaged over the 1993, 1994, and 1995 growing seasons.
[b] Relative yield is calculated as the yield for a specific variety minus the average yield for the trial. Relative yield data were averaged over the 1993, 1994, and 1995 growing seasons.

Table 7. Observation field trial of varieties and test lines mechanically harvested when ripe fruit was approaching optimum recovery. Results are averaged over 2 replicated plots.

Variety or Test line	Ripe Usable (T/A)	(sdev)	% of Potential Ripe	Green	Cull	Fruit Size (oz)	% Soluble Solids	pH	% Total Acid as Citric	Color Evaluation Hue	sdev
Harvest Date 9/6/95											
OX49	32.9	2.4	75.8	9.0	15.2	2.7	4.2	4.2	0.39	41.4	2.7
OX46	29.7	3.6	75.1	12.0	12.9	2.4	4.0	4.2	0.41	49.7	12.2
OX138	23.6	18.3	67.6	14.6	17.8	2.1	4.0	4.2	0.36	45.1	4.2
O4238	20.2	11.3	82.0	5.5	12.5	2.1	3.9	4.2	0.34	46.1	5.5
Harvest Date 9/7/95											
O94185	24.9	6.2	76.5	8.8	14.7	2.4	4.1	4.3	0.35	48.5	8.9
OX139	23.2	18.3	79.6	7.0	13.4	2.1	3.5	4.5	0.27	50.5	8.9
OX141	20.0	6.7	67.4	12.6	19.9	2.3	3.8	4.3	0.32	41.8	4.9
Harvest Date 9/8/95											
OX42	40.9	2.2	81.3	12.7	6.0	2.3	3.9	4.4	0.35	51.4	6.4
OX148	37.4	0.8	81.2	9.5	9.3	2.4	3.7	4.3	0.36	53.9	14.6
OX70	37.2	3.4	80.4	9.1	10.5	2.4	4.0	4.1	0.37	50.1	34.7
OX149	37.1	3.6	79.3	9.3	11.4	2.3	3.7	4.2	0.35	56.4	17.4
OX3	37.0	7.5	76.1	16.2	7.7	2.2	4.0	4.0	0.45	57.1	16.5
OX68	35.4	4.7	77.6	16.0	6.4	2.3	3.8	4.0	0.37	58.4	12.8
O4334	32.7	2.3	79.7	6.9	13.3	2.3	4.3	4.3	0.36	47.9	9.3
OX144	32.6	6.7	77.0	15.2	7.8	2.2	3.8	4.3	0.39	51.7	22.1
RCAT9201	32.4	0.8	75.8	10.2	14	2.4	4.0	4.3	0.35	50.0	6.6
O90390	32.4	0.8	80.9	14.4	4.7	2.1	4.0	4.1	0.37	56.9	11.1
OX147	32.0	8.7	81.8	7.1	11.1	2.1	3.9	4.3	0.40	46.2	3.5
OX110	31.9	9.9	74.0	17.1	8.9	2.2	4.0	4.2	0.38	42.5	34.1
OX4	30.6	4.2	75.6	12.2	12.2	2.7	4.1	4.2	0.44	34.6	21.1
E4344	29.9	4.4	75.4	8.5	16.1	2.2	3.8	4.2	0.39	51.3	5.3
OX146	29.1	17.6	78.2	9.3	12.5	2.0	4.3	4.2	0.35	50.4	7.2
O94173	28.8	3.8	68.7	19.9	11.4	2.6	4.0	4.3	0.36	34.2	40.3
O8990	28.5	4.9	74.8	12.6	12.6	2.5	4.1	4.2	0.41	50.0	13.7
O90383	28.1	0.7	74.9	11.8	13.4	2.4	3.7	4.2	0.42	53.3	8.4
O94187	27.9	9.8	81.4	12.5	6.1	2.2	5.0	4.2	0.40	56.8	16.2
E1858	26.9	12.0	76.1	18.2	5.7	2.5	4.6	4.2	0.27	51.8	23.6
E1857	26.4	5.5	68.9	19	12.1	2.3	4.6	4.6	0.44	51.8	8.2
O94174	25.6	6.7	79.9	8.4	11.7	2.3	4.5	4.2	0.32	54.7	12.3
OX113	25.2	14.2	76.2	10.2	13.6	2.6	4.2	4.1	0.33	48.4	6.8
O90393	24.2	0	78.5	7.3	14.1	2.1	4.2	4.2	0.44	50.3	4.9
E1873	24.1	0.1	82.5	8.5	9.0	2.4	4.5	4.3	0.32	48.8	9.1
OX121	22.0	15.8	83.2	4.3	12.5	2.6	5.0	4.2	0.44	48.8	7.3
OX120	21.3	9.8	77.2	6.8	16.0	2.5	4.5	4.3	0.36	50.4	6.2
E1854	19.1	4.0	65.5	20.6	13.9	2.6	4.3	4.2	0.39	53.7	8.7
E1852	16.1	7.5	78.8	10.6	10.6	2.3	5.3	4.3	0.45	50.3	5.1
Harvest Date 9/14/95											
OX34	40.4	2.9	81.9	9	9.1	2.6	3.6	4.3	0.53	46.5	3.4
OX5	39.8	1.1	80.7	8.5	10.8	2.6	3.7	4.3	0.55	45.2	2.5
OX72	39.5	0.4	76.0	12.4	11.6	2.2	3.4	4.3	0.39	45.9	3.6
OX64	36.6	4.7	79.4	6.4	14.2	2.0	3.7	4.2	0.48	52.1	6.1
LSD 0.05	14.46					0.34	0.75	0.23	0.10	9.59	
C.V.	7.02					2.31	8.25	2.35	12.10	27.25	

Table 7. Observation field trial of varieties and test lines mechanically harvested when ripe fruit was approaching optimum recovery. Results are averaged over 2 replicated plots. (Cont.)

Variety or Test line	Ripe Usable (T/A)	(sdev)	% of Potential Ripe	Green	Cull	Fruit Size (oz)	% Soluble Solids	pH	% Total Acid as Citric	Color Evaluation Hue	sdev
Harvest 9/14(cont.)											
O7983	34.5	1.3	82.7	5.9	11.3	2.5	4.5	4.2	0.53	46.0	3.4
OX150	33.8	6.2	76.1	10.8	13.0	2.2	4.1	4.3	0.46	46.3	2.6
OX151	33.8	6.5	72.3	15.9	11.9	2.3	3.3	4.4	0.40	46.6	3.6
OX71	32.6	0	81.0	3.7	15.3	2.5	3.8	4.3	0.47	47.7	4.2
E4289	32.4	5.1	76.7	6.9	16.3	2.6	3.7	4.4	0.46	45.5	3.2
OX88	32.3	5.8	79.9	4.6	15.4	2.3	3.8	4.3	0.42	47.6	2.7
O94186	31.9	6.0	80.6	10.4	8.9	2.1	3.8	4.3	0.51	47.3	2.2
E4323	31.8	3.2	75.2	9.2	15.6	2.1	3.2	4.3	0.33	46.4	2.8
O94179	31.6	5.6	79.6	8.3	12.1	2.0	3.8	4.3	0.53	44.8	2.8
OX17	30.5	1.8	77.7	6.7	15.6	2.5	4.1	4.3	0.38	47.1	3.0
O90389	27.4	2.0	78.0	5.1	16.9	2.7	3.8	4.3	0.47	45.9	4.1
E1859	26.4	10.4	79.5	13.3	7.2	2.4	4.1	4.3	0.43	44.1	2.9
O94183	26.3	0.8	79.2	7.2	13.6	2.3	4.2	4.1	0.61	47.8	2.6
OX140	26.0	21.0	71.0	15.4	13.6	2.1	4.0	4.3	0.44	48.2	5.3
O94184	24.7	0.1	77.4	4.7	17.9	2.4	3.8	4.3	0.53	46.2	3.4
OX129	23.6	10.4	79.1	4.8	16.1	2.6	4.3	4.3	0.50	46.4	5.1
E1851	18.2	0.8	67.4	14.8	17.8	2.6	4.6	4.3	0.51	43.2	3.8
Harvest Date 9/15/95											
H9422	45.2	0.4	77.2	18.7	4.1	2.4	4.1	4.4	0.32	45.5	3.3
H9423	44.9	1.1	78.9	15.3	5.8	2.3	4.6	4.1	0.33	49.5	8.7
H9314	43.4	4.8	83.8	9.8	6.4	2.2	4.0	4.3	0.31	59.3	10.3
OX52	41.9	1.6	83.8	9.0	7.2	2.1	3.7	4.2	0.33	51.3	10.0
PS696	40.7	0.6	85.5	8.4	6.2	2.5	3.9	4.3	0.33	50.6	9.7
OX53	40.4	4.1	75.5	13	11.5	2.2	3.5	4.4	0.26	50.7	11.4
OX74	40.0	3.3	83.0	8.6	8.4	2.7	3.8	4.4	0.34	47.4	12.6
O8245	39.0	1.3	79.4	16.9	3.7	2.4	4.0	4.3	0.34	50.0	8.6
OX60	37.1	4.4	83.9	7.3	8.8	2.5	4.0	4.3	0.31	53.5	10.9
OX80	36.7	3.5	78.9	9.5	11.6	2.6	4.0	4.4	0.30	38.9	31.1
E3097.2	36.2	3.9	81.6	9.8	8.6	2.4	4.3	4.3	0.30	51.3	7.5
E3097.3	35.6	1.9	83.7	8.3	8.0	2.2	3.7	4.3	0.32	48.2	4.3
PS2196	35.1	6.6	85.9	7.7	6.4	2.6	4.3	4.3	0.32	44.0	31.4
E3259	34.1	5.0	82.6	8.7	8.7	2.5	3.8	4.3	0.40	42.7	15.0
OX95	33.8	17.7	83.5	9.1	7.4	2.5	4.1	4.3	0.33	58.1	14.6
E4283	33.6	3.4	77.6	5.8	16.6	2.8	4.0	4.3	0.32	46.6	2.9
E3112	33.4	5.2	77.8	5.8	16.4	2.7	4.1	4.3	0.29	45.2	2.5
OX38	32.6	6.4	83.6	7.3	9.1	2.3	3.8	4.4	0.27	52.9	14.4
E1875	31.4	0.7	74.4	13.7	11.9	2.7	4.1	4.4	0.33	47.1	5.6
O8444	30.9	2.3	76.4	13.5	10	2.9	4.5	4.3	0.37	38.7	36.9
O94175	30.8	0.7	77.5	15.8	6.6	2.2	3.9	4.2	0.30	47.0	38.1
E3212	30.3	4.0	81.5	4.0	14.5	2.7	4.1	4.3	0.30	47.1	5.8
E1838	30.1	15.6	83.0	11.2	5.8	2.2	3.9	4.3	0.34	51.5	12.7
E3115	30.0	3.0	77.2	8.1	14.7	2.8	4.7	4.4	0.33	44.4	2.7
LSD(0.05)	14.46					0.34	0.75	0.23	0.10	9.59	
C.V.	0.3					2.31	8.25	2.35	12.10	27.25	

Table 7. Observation field trial of varieties and test lines mechanically harvested when ripe fruit was approaching optimum recovery. Results are averaged over 2 replicated plots. (Cont.)

Variety or Test line	Ripe Usable (T/A)	(sdev)	% of Potential Ripe	Green	Cull	Fruit Size (oz)	% Soluble Solids	pH	% Total Acid as Citric	Color Evaluation Hue	sdev
Harvest 9/15(cont.)											
E4338	29.6	2.9	77.9	12.6	9.5	2.7	4.2	4.3	0.30	44.8	4.2
O8556	29.3	2.5	75.4	9.9	14.7	2.7	4.0	4.4	0.29	47.0	5.6
E4339	28.7	1.0	77.2	9.3	13.5	2.9	4.5	4.5	0.28	45.7	4.3
O94181	28.3	5.4	74.1	9.8	16.1	2.4	4.2	4.4	0.31	50.9	9.6
E4297	28.1	0.1	71.7	9.0	19.3	2.6	4.0	4.3	0.31	51.6	10.6
E4242	25.3	12.6	70.4	18.2	11.5	2.5	4.3	4.4	0.31	40.6	33.2
E3096	23.3	7.8	71.6	12.9	15.5	2.6	3.9	4.4	0.32	48.5	5.8
O90381	20.3	9.7	75.1	11.1	13.9	1.9	4.0	4.3	0.29	58.9	13.7
LSD(0.05)	14.46					0.34	0.75	0.23	0.10	9.59	
C.V.	7.02					2.31	8.25	2.35	12.10	27.25	

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